Site: Area(s) where a hazardous substance has been deposited, stored, disposed, or placed, or has otherwise come to be located. Such areas may include multiple sources and may include the area between sources.

Slope factor (also referred to as cancer potency factor): Estimate of the probability of response (for example, cancer) per unit intake of a substance over a lifetime. The slope factor is typically used to estimate upper-bound probability of an individual developing cancer as a result of exposure to a particular level of a human carcinogen with a weight-of-evidence classification of A, B, or C. [(mg/kg-day)$^{-1}$ for non-radioactive substances and (pC$_i$)$^{-1}$ for radioactive substances].

Source: Any area where a hazardous substance has been deposited, stored, disposed, or placed, plus those soils that have become contaminated from migration of a hazardous substance. Sources do not include those volumes of air, ground water, surface water, or surface water sediments that have become contaminated by migration, except: in the case of either a ground water plume with no identified source or contaminated surface water sediments with no identified source, the plume or contaminated sediments may be considered a source.

Target distance limit: Maximum distance over which targets for the site are evaluated. The target distance limit varies by HRS pathway.

Uranium Mill Tailings Radiation Control Act (UMTRCA) Standards: Standards for radionuclides established under sections 102, 104, and 108 of the Uranium Mill Tailings Radiation Control Act, as amended.

Vapor pressure: Pressure exerted by the vapor of a substance when it is in equilibrium with its solid or liquid form at a given temperature. For HRS purposes, use the value reported at or near 25° C. [atmosphere or torr].

Volatilization: Physical transfer process through which a substance undergoes a change of state from a solid or liquid to a gas.

Water solubility: Maximum concentration of a substance in pure water at a given temperature. For HRS purposes, use the value reported at or near 25° C. [milligrams per liter (mg/l)].

Weight-of-evidence: EPA classification system for characterizing the evidence supporting the designation of a substance as a human carcinogen. EPA weight-of-evidence groupings include:

Group A: Human carcinogen--sufficient evidence of carcinogenicity in humans.
Group B1: Probable human carcinogen--limited evidence of carcinogenicity in humans.
Group B2: Probable human carcinogen--sufficient evidence of carcinogenicity in animals.
Group C: Possible human carcinogen--limited evidence of carcinogenicity in animals.
Group D: Not classifiable as to human carcinogenicity--applicable when there is no animal evidence, or when human or animal evidence is inadequate.
Group E: Evidence of noncarcinogenicity for humans.

2.0 Evaluations Common to Multiple Pathways

2.1 Overview. The HRS site score (S) is the result of an evaluation of four pathways:
- Ground Water Migration (S$_{gw}$).
- Surface Water Migration (S$_{sw}$).
- Soil Exposure (S$_s$).
- Air Migration (S$_a$).

The ground water and air migration pathways use single threat evaluations, while the surface water migration and soil exposure pathways use multiple threat evaluations. Three threats are evaluated for the surface water migration pathway: drinking water, human food chain, and environmental. These threats are evaluated for two separate migration components--overland/flood migration and ground water to surface water migration. Two threats are evaluated for the soil exposure pathway: resident population and nearby population.

The HRS is structured to provide a parallel evaluation for each of these pathways and threats. This section focuses on these parallel evaluations, starting with the calculation of the HRS site score and the individual pathway scores.

2.1.1 Calculation of HRS site score. Scores are first calculated for the individual pathways as specified in sections 2 through 7 and then are combined for the site using the following root-mean-square equation to determine the overall HRS site score, which ranges from 0 to 100:

$$S = \sqrt{\frac{S_{gw}^2 + S_{sw}^2 + S_{s}^2 + S_{a}^2}{4}}$$

2.1.2 Calculation of pathway score. Table 2-1, which is based on the air migration pathway, illustrates the basic parameters used to calculate a pathway score. As Table 2-1 shows, each pathway (or threat) score is the product of three "factor categories": likelihood of release, waste characteristics, and targets. (The soil exposure pathway uses likelihood of exposure rather than likelihood of release.) Each of the three factor categories contains a set of factors that are assigned numerical values and combined as specified in sections 2 through 7. The factor values are rounded to the nearest integer, except where otherwise noted.

2.1.3 Common evaluations. Evaluations common to all four HRS pathways include:
- Characterizing sources.
  - Identifying sources (and, for the soil exposure pathway, areas of observed contamination [see section 5.0.1]).
  - Identifying hazardous substances associated with each source (or area of observed contamination).
  - Identifying hazardous substances available to a pathway.

TABLE 2-1.—SAMPLE PATHWAY SCORESHEET

Factor category	Maximum value	Value assigned
Likelihood of Release		
1. Observed Release	550	
2. Potential to Release	500	
3. Likelihood of Release (higher of lines 1 and 2)	550	
Waste Characteristics		
4. Toxicity/Mobility	(a)	
5. Hazardous Waste Quantity	(a)	
6. Waste Characteristics	100	
Targets		
7. Nearest Individual		
7a. Level I	50	
7b. Level II	45	
7c. Potential Contamination	20	
7d. Nearest Individual (higher of lines 7a, 7b, or 7c)	50	
8. Population		
8a. Level I	(b)	
8b. Level II	(b)	
8c. Potential Contamination	(b)	
8d. Total Population (lines 8a+8b+8c)	(b)	
9. Resources	5	
10. Sensitive Environments	(b)	
10a. Actual Contamination	(b)	
10b. Potential Contamination	(b)	
10c. Sensitive Environments (lines 10a+10b)	(b)	
11. Targets (lines 7d+8d+9+10c)	(b)	
12. **Pathway Score** is the product of Likelihood of Release, Waste Characteristics, and Targets, divided by 82,500. Pathway scores are limited to a maximum of 100 points.		

[a] Maximum value applies to waste characteristics category. The product of lines 4 and 5 is used in Table 2-7 to derive the value for the waste characteristics factor category.
[b] There is no limit to the human population or sensitive environments factor values. However, the pathway score based solely on sensitive environments is limited to a maximum of 60 points.

- Scoring likelihood of release (or likelihood of exposure) factor category.
  - Scoring observed release (or observed contamination).
  - Scoring potential to release when there is no observed release.
- Scoring waste characteristics factor category.
  - Evaluating toxicity.
  - Combining toxicity with mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential, as appropriate to the pathway (or threat).
  - Evaluating hazardous waste quantity.
  - Combining hazardous waste quantity with the other waste characteristics factors.
  - Determining waste characteristics factor category value.
- Scoring targets factor category.
  - Determining level of contamination for targets.

These evaluations are essentially identical for the three migration pathways (ground water, surface water, and air). However, the

evaluations differ in certain respects for the soil exposure pathway.

Section 7 specifies modifications that apply to each pathway when evaluating sites containing radioactive substances.

Section 2 focuses on evaluations common at the pathway and threat levels. Note that for the ground water and surface water migration pathways, separate scores are calculated for each aquifer (see section 3.0) and each watershed (see sections 4.1.1.3 and 4.2.1.5) when determining the pathway scores for a site. Although the evaluations in section 2 do not vary when different aquifers or watersheds are scored at a site, the specific factor values (for example, observed release,

hazardous waste quantity, toxicity/mobility) that result from these evaluations can vary by aquifer and by watershed at the site. This can occur through differences both in the specific sources and targets eligible to be evaluated for each aquifer and watershed and in whether observed releases can be established for each aquifer and watershed. Such differences in scoring at the aquifer and watershed level are addressed in sections 3 and 4, not section 2.

2.2 *Characterize sources.* Source characterization includes identification of the following:

• Sources (and areas of observed contamination) at the site.

• Hazardous substances associated with these sources (or areas of observed contamination).

• Pathways potentially threatened by these hazardous substances.

Table 2-2 presents a sample worksheet for source characterization.

2.2.1 *Identify sources.* For the three migration pathways, identify the sources at the site that contain hazardous substances. Identify the migration pathway(s) to which each source applies. For the soil exposure pathway, identify areas of observed contamination at the site (see section 5.0.1).

TABLE 2-2.—SAMPLE SOURCE CHARACTERIZATION WORKSHEET

Source: _____

A. Source dimensions and hazardous waste quantity.

Hazardous constituent quantity: _____

Hazardous wastestream quantity: _____

Volume: _____

Area: _____

Area of observed contamination: _____

B. Hazardous substances associated with the source.

Hazardous substance	Available to pathway						
	Air		Ground water (GW)	Surface water (SW)		Soil	
	Gas	Particulate		Overland/ flood	GW to SW	Resident	Nearby

2.2.2 *Identify hazardous substances associated with a source.* For each of the three migration pathways, consider those hazardous substances documented in a source (for example, by sampling, labels, manifests, oral or written statements) to be associated with that source when evaluating each pathway. In some instances, a hazardous substance can be documented as being present at a site (for example, by labels, manifests, oral or written statements), but the specific source(s) containing that hazardous substance cannot be documented. For the three migration pathways, in those instances when the specific source(s) cannot be documented for a hazardous substance, consider the hazardous substance to be present in each source at the site, except sources for which definitive information indicates that the hazardous substance was not or could not be present.

For an area of observed contamination in the soil exposure pathway, consider only those hazardous substances that meet the criteria for observed contamination for that area (see section 5.0.1) to be associated with that area when evaluating the pathway.

2.2.3 *Identify hazardous substances available to a pathway.* In evaluating each

migration pathway, consider the following hazardous substances available to migrate from the sources at the site to the pathway:

• Ground water migration.

–Hazardous substances that meet the criteria for an observed release (see section 2.3) to ground water.

–All hazardous substances associated with a source with a ground water containment factor value greater than 0 (see section 3.1.2.1).

• Surface water migration—overland/flood component.

–Hazardous substances that meet the criteria for an observed release to surface water in the watershed being evaluated.

–All hazardous substances associated with a source with a surface water containment factor value greater than 0 for the watershed (see sections 4.1.2.1.2.1.1 and 4.1.2.1.2.2.1).

• Surface water migration—ground water to surface water component.

–Hazardous substances that meet the criteria for an observed release to ground water.

–All hazardous substances associated with a source with a ground water containment factor value greater than 0 (see sections 4.2.2.1.2 and 3.1.2.1).

• Air migration.

–Hazardous substances that meet the criteria for an observed release to the atmosphere.

–All gaseous hazardous substances associated with a source with a gas containment factor value greater than 0 (see section 6.1.2.1.1).

–All particulate hazardous substances associated with a source with a particulate containment factor value greater than 0 (see section 6.1.2.2.1).

• For each migration pathway, in those instances when the specific source(s) containing the hazardous substance cannot be documented, consider that hazardous substance to be available to migrate to the pathway when it can be associated (see section 2.2.2) with at least one source having a containment factor value greater than 0 for that pathway.

In evaluating the soil exposure pathway, consider the following hazardous substances available to the pathway:

- Soil exposure—resident population threat.
  - –All hazardous substances that meet the criteria for observed contamination at the site (see section 5.0.1).
- Soil exposure—nearby population threat.
  - –All hazardous substances that meet the criteria for observed contamination at areas with an attractiveness/accessibility factor value greater than 0 (see section 5.2.1.1).

2.3 *Likelihood of release.* Likelihood of release is a measure of the likelihood that a waste has been or will be released to the environment. The likelihood of release factor category is assigned the maximum value of 550 for a migration pathway whenever the criteria for an observed release are met for that pathway. If the criteria for an observed release are met, do not evaluate potential to release for that pathway. When the criteria for an observed release are not met, evaluate potential to release for that pathway, with a maximum value of 500. The evaluation of potential to release varies by migration pathway (see sections 3, 4 and 6).

Establish an observed release either by direct observation of the release of a hazardous substance into the media being evaluated (for example, surface water) or by chemical analysis of samples appropriate to the pathway being evaluated (see sections 3, 4, and 6). The minimum standard to establish an observed release by chemical analysis is analytical evidence of a hazardous substance in the media significantly above the background level. Further, some portion of the release must be attributable to the site. Use the criteria in Table 2–3 as the standard for determining analytical significance. (The criteria in Table 2–3 are also used in establishing observed contamination for the soil exposure pathway, see section 5.0.1.) Separate criteria apply to radionuclides (see section 7.1.1).

TABLE 2–3.—OBSERVED RELEASE CRITERIA FOR CHEMICAL ANALYSIS

Sample Measurement < Sample Quantitation Limit [a]
No observed release is established.
Sample Measurement ≥ SAMPLE QUANTITATION LIMIT [a]
An observed release is established as follows:
- If the background concentration is not detected (or is less than the detection limit), an observed release is established when the sample measurement equals or exceeds the sample quantitation limit.[a]
- If the background concentration equals or exceeds the detection limit, an observed release is established when the sample measurement is 3 times or more above the background concentration.

[a] If the sample quantitation limit (SQL) cannot be established, determined if there is an observed release as follows:

—If the sample analysis was performed under the EPA Contract Laboratory Program, use the EPA contract-required quantitation limit (CRQL) in place of the SQL.
—If the sample analysis is not performed under the EPA Contract Laboratory Program, use the detection limit (DL) in place of the SQL.

2.4 *Waste characteristics.* The waste characteristics factor category includes the following factors: hazardous waste quantity, toxicity, and as appropriate to the pathway or threat being evaluated, mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential.

2.4.1 *Selection of substance potentially posing greatest hazard.* For all pathways (and threats), select the hazardous substance potentially posing the greatest hazard for the pathway (or threat) and use that substance in evaluating the waste characteristics category of the pathway (or threat). For the three migration pathways (and threats), base the selection of this hazardous substance on the toxicity factor value for the substance, combined with its mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factor values, as applicable to the migration pathway (or threat). For the soil exposure pathway, base the selection on the toxicity factor alone.

Evaluation of the toxicity factor is specified in section 2.4.1.1. Use and evaluation of the mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factors vary by pathway (or threat) and are specified under the appropriate pathway (or threat) section. Section 2.4.1.2 identifies the specific factors that are combined with toxicity in evaluating each pathway (or threat).

2.4.1.1 *Toxicity factor.* Evaluate toxicity for those hazardous substances at the site that are available to the pathway being scored. For all pathways and threats, except the surface water environmental threat, evaluate human toxicity as specified below. For the surface water environmental threat, evaluate ecosystem toxicity as specified in section 4.1.4.2.1.1.

Establish human toxicity factor values based on quantitative dose-response parameters for the following three types of toxicity:
- Cancer––Use slope factors (also referred to as cancer potency factors) combined with weight-of-evidence ratings for carcinogenicity. If a slope factor is not available for a substance, use its ED_{10} value to estimate a slope factor as follows:

$$\text{Slope factor} = \frac{1}{6 \ (ED_{10})}$$

- Noncancer toxicological responses of chronic exposure––use reference dose (RfD) values.

- Noncancer toxicological responses of acute exposure––use acute toxicity parameters, such as the LD_{50}.

Assign human toxicity factor values to a hazardous substance using Table 2–4, as follows:
- If RfD and slope factor values are both available for the hazardous substance, assign the substance a value from Table 2–4 for each. Select the higher of the two values assigned and use it as the overall toxicity factor value for the hazardous substance.
- If either an RfD or slope factor value is available, but not both, assign the hazardous substance an overall toxicity factor value from Table 2–4 based solely on the available value (RfD or slope factor).
- If neither an RfD nor slope factor value is available, assign the hazardous substance an overall toxicity factor value from Table 2–4 based solely on acute toxicity. That is, consider acute toxicity in Table 2–4 only when both RfD and slope factor values are not available.
- If neither an RfD, nor slope factor, nor acute toxicity value is available, assign the hazardous substance an overall toxicity factor value of 0 and use other hazardous substances for which information is available in evaluating the pathway.

TABLE 2–4.—TOXICITY FACTOR EVALUATION

Chronic Toxicity (Human)

Reference dose (RfD) (mg/kg-day)	Assigned value
RfD < 0.0005	10,000
0.0005 ≤ RfD < 0.005	1,000
0.005 ≤ RfD < 0.05	100
0.05 ≤ RfD < 0.5	10
0.5 ≤ RfD	1
RfD not available	0

Carcinogenicity (Human)

Weight-of-evidence[a]/slope factor (mg/kg-day)⁻¹			Assigned value
A	B	C	
0.5 ≤ SF[b]	5 ≤ SF	50 ≤ SF	10,000
0.05 ≤ SF < 0.5	0.5 ≤ SF < 5	5 ≤ SF < 50	1,000
SF < 0.05	0.05 ≤ SF < 0.5	0.5 ≤ SF < 5	100
— — —	SF < 0.05	SF < 0.5	10
Slope factor not available.	Slope factor not available.	Slope factor not available.	0

[a] A, B, and C refer to weight-of-evidence categories. Assign substances with a weight-of-evidence category of D (inadequate evidence of carcinogenicity) or E (evidence of lack of carcinogenicity) a value of 0 for carcinogenicity.
[b] SF = Slope factor.

TABLE 2-4.—TOXICITY FACTOR EVALUATION—CONCLUDED

Acute Toxicity (Human)

Oral LD$_{50}$ (mg/kg)	Dermal LD$_{50}$ (mg/kg)	Dust or mist LC$_{50}$ (mg/l)	Gas or vapor LC$_{50}$ (ppm)	Assigned value
LD$_{50}$ < 5	LD$_{50}$ < 2	LC$_{50}$ < 0.2	LC$_{50}$ < 20	—
5 ≤ LD$_{50}$ < 50	2 ≤ LD$_{50}$ < 20	0.2 ≤ LC$_{50}$ < 2	20 ≤ LC$_{50}$ < 200	1,000
50 ≤ LD$_{50}$ < 500	20 ≤ LD$_{50}$ < 200	2 ≤ LC$_{50}$ < 20	200 ≤ LC$_{50}$ < 2,000	100
500 ≤ LD$_{50}$	200 ≤ LD$_{50}$	20 ≤ LC$_{50}$	2,000 ≤ LC$_{50}$	10
LD$_{50}$ not available	LD$_{50}$ not available	LC$_{50}$ not available	LC$_{50}$ not available	1
				0

If a toxicity factor value of 0 is assigned to all hazardous substances available to a particular pathway (that is, insufficient toxicity data are available for evaluating all the substances), use a default value of 100 as the overall human toxicity factor value for all hazardous substances available to the pathway. For hazardous substances having usable toxicity data for multiple exposure routes (for example, inhalation and ingestion), consider all exposure routes and use the highest assigned value, regardless of exposure route, as the toxicity factor value.

For HRS purposes, assign both asbestos and lead (and its compounds) a human toxicity factor value of 10,000.

Separate criteria apply for assigning factor values for human toxicity and ecosystem toxicity for radionuclides (see sections 7.2.1 and 7.2.2).

2.4.1.2 *Hazardous substance selection.* For each hazardous substance evaluated for a migration pathway (or threat), combine the human toxicity factor value (or ecosystem toxicity factor value) for the hazardous substance with a mobility, persistence, and/ or bioaccumulation (or ecosystem bioaccumulation) potential factor value as follows:

• Ground water migration.

–Determine a combined human toxicity/ mobility factor value for the hazardous substance (see section 3.2.1).

• Surface water migration-overland/flood migration component.

–Determine a combined human toxicity/ persistence factor value for the hazardous substance for the drinking water threat (see section 4.1.2.2.1).
–Determine a combined human toxicity/ persistence/bioaccumulation factor value for the hazardous substance for the human food chain threat (see section 4.1.3.2.1).
–Determine a combined ecosystem toxicity/persistence/bioaccumulation factor value for the hazardous substance for the environmental threat (see section 4.1.4.2.1).

• Surface water migration-ground water to surface water migration component.

–Determine a combined human toxicity/ mobility/persistence factor value for the hazardous substance for the drinking water threat (see section 4.2.2.2.1).
–Determine a combined human toxicity/ mobility/persistence/bioaccumulation factor value for the hazardous substance for the human food chain threat (see section 4.2.3.2.1).

–Determine a combined ecosystem toxicity/mobility/persistence/ bioaccumulation factor value for the hazardous substance for the environmental threat (see section 4.2.4.2.1).

• Air migration.

–Determine a combined human toxicity/ mobility factor value for the hazardous substance (see section 6.2.1).

Determine each combined factor value for a hazardous substance by multiplying the individual factor values appropriate to the pathway (or threat). For each migration pathway (or threat) being evaluated, select the hazardous substance with the highest combined factor value and use that substance in evaluating the waste characteristics factor category of the pathway (or threat).

For the soil exposure pathway, select the hazardous substance with the highest human toxicity factor value from among the substances that meet the criteria for observed contamination for the threat evaluated and use that substance in evaluating the waste characteristics factor category.

2.4.2 *Hazardous waste quantity.* Evaluate the hazardous waste quantity factor by first assigning each source (or area of observed contamination) a source hazardous waste quantity value as specified below. Sum these values to obtain the hazardous waste quantity factor value for the pathway being evaluated.

In evaluating the hazardous waste quantity factor for the three migration pathways, allocate hazardous substances and hazardous wastestreams to specific sources in the manner specified in section 2.2.2, except: consider hazardous substances and hazardous wastestreams that cannot be allocated to any specific source to constitute a separate "unallocated source" for purposes of evaluating only this factor for the three migration pathways. Do not, however, include a hazardous substance or hazardous wastestream in the unallocated source for a migration pathway if there is definitive information indicating that the substance or wastestream could only have been placed in sources with a containment factor value of 0 for that migration pathway.

In evaluating the hazardous waste quantity factor for the soil exposure pathway, allocate to each area of observed contamination only those hazardous substances that meet the criteria for observed contamination for that area of observed contamination and only those hazardous wastestreams that contain hazardous substances that meet the criteria for observed contamination for that area of

observed contamination. Do not consider other hazardous substances or hazardous wastestreams at the site in evaluating this factor for the soil exposure pathway.

2.4.2.1 *Source hazardous waste quantity.* For each of the three migration pathways, assign a source hazardous waste quantity value to each source (including the unallocated source) having a containment factor value greater than 0 for the pathway being evaluated. Consider the unallocated source to have a containment factor value greater than 0 for each migration pathway.

For the soil exposure pathway, assign a source hazardous waste quantity value to each area of observed contamination, as applicable to the threat being evaluated.

For all pathways, evaluate source hazardous waste quantity using the following four measures in the following hierarchy:

• Hazardous constituent quantity.
• Hazardous wastestream quantity.
• Volume.
• Area.

For the unallocated source, use only the first two measures.

Separate criteria apply for assigning a source hazardous waste quantity value for radionuclides (see section 7.2.5).

2.4.2.1.1 *Hazardous constituent quantity.* Evaluate hazardous constituent quantity for the source (or area of observed contamination) based solely on the mass of CERCLA hazardous substances (as defined in CERCLA section 101(14), as amended) allocated to the source (or area of observed contamination), except:

• For a hazardous waste listed pursuant to section 3001 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976 (RCRA), 42 U.S.C. 6901 et seq., determine its mass for the evaluation of this measure as follows:

–If the hazardous waste is listed solely for Hazard Code T (toxic waste), include only the mass of constituents in the hazardous waste that are CERCLA hazardous substances and not the mass of the entire hazardous waste.

–If the hazardous waste is listed for any other Hazard Code (including T plus any other Hazard Code), include the mass of the entire hazardous waste.

• For a RCRA hazardous waste that exhibits the characteristics identified under section 3001 of RCRA, as amended, determine its mass for the evaluation of this measure as follows:

–If the hazardous waste exhibits only the characteristic of toxicity (or only the characteristic of EP toxicity), include only the mass of constituents in the hazardous waste that are CERCLA hazardous substances and not the mass of the entire hazardous waste.

–If the hazardous waste exhibits any other characteristic identified under section 3001 (including any other characteristic plus the characteristic of toxicity [or the characteristic of EP toxicity]), include the mass of the entire hazardous waste.

Based on this mass, designated as C, assign a value for hazardous constituent quantity as follows:

• For the migration pathways, assign the source a value for hazardous constituent quantity using the Tier A equation of Table 2-5.

• For the soil exposure pathway, assign the area of observed contamination a value using the Tier A equation of Table 5-2 (section 5.1.2.2).

If the hazardous constituent quantity for the source (or area of observed contamination) is adequately determined (that is, the total mass of all CERCLA hazardous substances in the source and releases from the source [or in the area of observed contamination] is known or is estimated with reasonable confidence), do not evaluate the other three measures discussed below. Instead assign these other three measures a value of 0 for the source (or area of observed contamination) and proceed to section 2.4.2.1.5.

If the hazardous constituent quantity is not adequately determined, assign the source (or area of observed contamination) a value for hazardous constituent quantity based on the available data and proceed to section 2.4.2.1.2.

TABLE 2-5.—HAZARDOUS WASTE QUANTITY EVALUATION EQUATIONS

Tier	Measure	Units	Equation for assigning value a
A	**Hazardous constituent quantity (C)**	lb	C
B b	**Hazardous wastestream quantity (W)**	lb	W/5,000
C b	**/olume (V)**		
	Landfill	yd³	V/2,500
	Surface impoundment	yd³	V/2.5
	Surface impoundment (buried/backfilled)	yd³	V/2.5
	Drums c	gallon	V/500
	Tanks and containers other than drums	yd³	V/2.5
	Contaminated soil	yd³	V/2,500
	Pile	yd³	V/2.5
	Other	yd³	V/2.5
D b	**Area (A)**		
	Landfill	ft²	A/3,400
	Surface impoundment	ft²	A/13

TABLE 2-5.—HAZARDOUS WASTE QUANTITY EVALUATION EQUATIONS—Concluded

Tier	Measure	Units	Equation for assigning value a
	Surface impoundment (buried/backfilled)	ft²	A/13
	Land treatment	ft²	A/270
	Pile d	ft²	A/13
	Contaminated soil	ft²	A/34,000

a Do not round to nearest integer.
b Convert volume to mass when necessary: 1 ton=2,000 pounds=1 cubic yard=4 drums=200 gallons.
c If actual volume of drums is unavailable, assume 1 drum=50 gallons.
d Use land surface area under pile, not surface area of pile.

2.4.2.1.2 *Hazardous wastestream quantity.* Evaluate hazardous wastestream quantity for the source (or area of observed contamination) based on the mass of hazardous wastestreams plus the mass of any additional CERCLA pollutants and contaminants (as defined in CERCLA section 101[33], as amended) that are allocated to the source (or area of observed contamination). For a wastestream that consists solely of a hazardous waste listed pursuant to section 3001 of RCRA, as amended or that consists solely of a RCRA hazardous waste that exhibits the characteristics identified under section 3001 of RCRA, as amended, include the mass of that entire hazardous waste in the evaluation of this measure.

Based on this mass, designated as W, assign a value for hazardous wastestream quantity as follows:

• For the migration pathways, assign the source a value for hazardous wastestream quantity using the Tier B equation of Table 2-5.

• For the soil exposure pathway, assign the area of observed contamination a value using the Tier B equation of Table 5-2 (section 5.1.2.2).

Do not evaluate the volume and area measures described below if the source is the unallocated source or if the following condition applies:

• The hazardous wastestream quantity for the source (or area of observed contamination) is adequately determined—that is, total mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source (or for the area of observed contamination) is known or is estimated with reasonable confidence.

If the source is the unallocated source or if this condition applies, assign the volume and area measures a value of 0 for the source (or area of observed contamination) and proceed to section 2.4.2.1.5. Otherwise, assign the source (or area of observed contamination) a value for hazardous wastestream quantity based on the available data and proceed to section 2.4.2.1.3.

2.4.2.1.3 *Volume.* Evaluate the volume measure using the volume of the source (or the volume of the area of observed

contamination). For the soil exposure pathway, restrict the use of the volume measure to those areas of observed contamination specified in section 5.1.2.2.

Based on the volume, designated as V, assign a value to the volume measure as follows:

• For the migration pathways, assign the source a value for volume using the appropriate Tier C equation of Table 2-5.

• For the soil exposure pathway, assign the area of observed contamination a value for volume using the appropriate Tier C equation of Table 5-2 (section 5.1.2.2).

If the volume of the source (or volume of the area of observed contamination, if applicable) can be determined, do not evaluate the area measure. Instead, assign the area measure a value of 0 and proceed to section 2.4.2.1.5. If the volume cannot be determined (or is not applicable for the soil exposure pathway), assign the source (or area of observed contamination) a value of 0 for the volume measure and proceed to section 2.4.2.1.4.

2.4.2.1.4 *Area.* Evaluate the area measure using the area of the source (or the area of the area of observed contamination). Based on this area, designated as A, assign a value to the area measure as follows:

• For the migration pathways, assign the source a value for area using the appropriate Tier D equation of Table 2-5.

• For the soil exposure pathway, assign the area of observed contamination a value for area using the appropriate Tier D equation of Table 5-2 (section 5.1.2.2).

2.4.2.1.5 *Calculation of source hazardous waste quantity value.* Select the highest of the values assigned to the source (or area of observed contamination) for the hazardous constituent quantity, hazardous wastestream quantity, volume, and area measures. Assign this value as the source hazardous waste quantity value. Do not round to the nearest integer.

2.4.2.2 *Calculation of hazardous waste quantity factor value.* Sum the source hazardous waste quantity values assigned to all sources (including the unallocated source) or areas of observed contamination for the pathway being evaluated and round this sum to the nearest integer, except: if the sum is greater than 0, but less than 1, round it to 1. Based on this value, select a hazardous waste quantity factor value for the pathway from Table 2-6.

TABLE 2-6.—HAZARDOUS WASTE QUANTITY FACTOR VALUES

Hazardous waste quantity value	Assigned value
0	0
1 a to 100	1 b
Greater than 100 to 10,000	100
Greater than 10,000 to 1,000,000	10,000
Greater than 1,000,000	1,000,000

a If the hazardous waste quantity value is greater than 0, but less than 1, round it to 1 as specified in text.
b For the pathway, if hazardous constituent quantity is not adequately determined, assign a value as specified in the text; do not assign the value of 1.

For a migration pathway, if the hazardous constituent quantity is adequately determined (see section 2.4.2.1.1) for all sources (or all portions of sources and releases remaining after a removal action), assign the value from Table 2–6 as the hazardous waste quantity factor value for the pathway. If the hazardous constituent quantity is not adequately determined for one or more sources (or one or more portions of sources or releases remaining after a removal action) assign a factor value as follows:

• If any target for that migration pathway is subject to Level I or Level II concentrations (see section 2.5), assign either the value from Table 2–6 or a value of 100, whichever is greater, as the hazardous waste quantity factor value for that pathway.

• If none of the targets for that pathway is subject to Level I or Level II concentrations, assign a factor value as follows:

–If there has been no removal action, assign either the value from Table 2–6 or a value of 10, whichever is greater, as the hazardous waste quantity factor value for that pathway.

–If there has been a removal action:

––Determine values from Table 2–6 with and without consideration of the removal action.

––If the value that would be assigned from Table 2–6 without consideration of the removal action would be 100 or greater, assign either the value from Table 2–6 with consideration of the removal action or a value of 100, whichever is greater, as the hazardous waste quantity factor value for the pathway.

––If the value that would be assigned from Table 2–6 without consideration of the removal action would be less than 100, assign a value of 10 as the hazardous waste quantity factor value for the pathway.

For the soil exposure pathway, if the hazardous constituent quantity is adequately determined for all areas of observed contamination, assign the value from Table 2–6 as the hazardous waste quantity factor value. If the hazardous constituent quantity is not adequately determined for one or more areas of observed contamination, assign either the value from Table 2–6 or a value of 10, whichever is greater, as the hazardous waste quantity factor value.

2.4.3 *Waste characteristics factor category value.* Determine the waste characteristics factor category value as specified in section 2.4.3.1 for all pathways and threats, except the surface water-human food chain threat and the surface water-environmental threat. Determine the waste characteristics factor category value for these latter two threats as specified in section 2.4.3.2.

2.4.3.1 *Factor category value.* For the pathway (or threat) being evaluated, multiply the toxicity or combined factor value, as appropriate, from section 2.4.1.2 and the hazardous waste quantity factor value from section 2.4.2.2, subject to a maximum product of 1×10^8. Based on this waste characteristics product assign a waste characteristics factor

category value to the pathway (or threat) from Table 2–7.

TABLE 2–7.—WASTE CHARACTERISTICS FACTOR CATEGORY VALUES

Waste characteristics product	Assigned value
0	0
Greater than 0 to less than 10	1
10 to less than 1×10^2	2
1×10^2 to less than 1×10^3	3
1×10^3 to less than 1×10^4	6
1×10^4 to less than 1×10^5	10
1×10^5 to less than 1×10^6	18
1×10^6 to less than 1×10^7	32
1×10^7 to less than 1×10^8	56
1×10^8 to less than 1×10^9	100
1×10^9 to less than 1×10^{10}	180
1×10^{10} to less than 1×10^{11}	320
1×10^{11} to less than 1×10^{12}	560
1×10^{12}	1,000

2.4.3.2 *Factor category value, considering bioaccumulation potential.* For the surface water-human food chain threat and the surface water-environmental threat, multiply the toxicity or combined factor value, as appropriate, from section 2.4.1.2 and the hazardous waste quantity factor value from section 2.4.2.2, subject to:

• A maximum product of 1×10^{12}, and

• A maximum product exclusive of the bioaccumulation (or ecosystem bioaccumulation) potential factor of 1×10^8.

Based on the total waste characteristics product, assign a waste characteristics factor category value to these threats from Table 2–7.

2.5 *Targets.*

The types of targets evaluated include the following:

• Individual (factor name varies by pathway and threat).

• Human population.

• Resources (these vary by pathway and threat).

• Sensitive environments (included for all pathways except ground water migration).

The factor values that may be assigned to each type of target have the same range for each pathway for which that type of target is evaluated. The factor value for most types of targets depends on whether the target is subject to actual or potential contamination for the pathway and whether the actual contamination is Level I or Level II:

• Actual contamination: Target is associated either with a sampling location that meets the criteria for an observed release (or observed contamination) for the pathway or with an observed release based on direct observation for the pathway (additional criteria apply for establishing actual contamination for the human food chain threat in the surface water migration pathway, see sections 4.1.3.3 and 4.2.3.3). sections 3 through 6 specify how to determine the targets associated with a sampling location or with an observed release based on direct observation. Determine whether the actual contamination is Level I or Level II as follows:

–Level I:

––Media-specific concentrations for the target meet the criteria for an

observed release (or observed contamination) for the pathway and are at or above media-specific benchmark values. These benchmark values (see section 2.5.2) include both screening concentrations and concentrations specified in regulatory limits (such as Maximum Contaminant Level (MCL) values), or

––For the human food chain threat in the surface water migration pathway, concentrations in tissue samples from aquatic human food chain organisms are at or above benchmark values. Such tissue samples may be used in addition to media-specific concentrations only as specified in sections 4.1.3.3 and 4.2.3.3.

–Level II:

––Media-specific concentrations for the target meet the criteria for an observed release (or observed contamination) for the pathway, but are less than media-specific benchmarks. If none of the hazardous substances eligible to be evaluated for the sampling location has an applicable benchmark, assign Level II to the actual contamination at the sampling location, or

––For observed releases based on direct observation, assign Level II to targets as specified in sections 3, 4, and 6, or

––For the human food chain threat in the surface water migration pathway, concentrations in tissue samples from aquatic human food chain organisms, when applicable, are below benchmark values.

–If a target is subject to both Level I and Level II concentrations for a pathway (or threat), evaluate the target using Level I concentrations for that pathway (or threat).

• Potential contamination: Target is subject to a potential release (that is, target is not associated with actual contamination for that pathway or threat).

Assign a factor value for individual risk as follows (select the highest value that applies to the pathway or threat):

• 50 points if any individual is exposed to Level I concentrations.

• 45 points if any individual is exposed to Level II concentrations.

• Maximum of 20 points if any individual is subject to potential contamination. The value assigned is 20 multiplied by the distance or dilution weight appropriate to the pathway.

Assign factor values for population and sensitive environments as follows:

• Sum Level I targets and multiply by 10. (Level I is not used for sensitive environments in the soil exposure and air migration pathways.)

• Sum Level II targets.

• Multiply potential targets by distance or dilution weights appropriate to the pathway, sum, and divide by 10. Distance or dilution weighting accounts for diminishing exposure

with increasing distance or dilution within the different pathways.
• Sum the values for the three levels.
In addition, resource value points are assigned within all pathways for welfare-related impacts (for example, impacts to agricultural land), but do not depend on whether there is actual or potential contamination.

2.5.1 *Determination of level of actual contamination at a sampling location.* Determine whether Level I concentrations or Level II concentrations apply at a sampling location (and thus to the associated targets) as follows:
• Select the benchmarks applicable to the pathway (or threat) being evaluated.
• Compare the concentrations of hazardous substances in the sample (or comparable samples) to their benchmark concentrations for the pathway (or threat), as specified in section 2.5.2.
• Determine which level applies based on this comparison.
• If none of the hazardous substances eligible to be evaluated for the sampling location has an applicable benchmark, assign Level II to the actual contamination at that sampling location for the pathway (or threat).

In making the comparison, consider only those samples, and only those hazardous substances in the sample, that meet the criteria for an observed release (or observed contamination) for the pathway, except: tissue samples from aquatic human food chain organisms may also be used as specified in sections 4.1.3.3 and 4.2.3.3 of the surface water-human food chain threat. If any hazardous substance is present in more than one comparable sample for the sampling location, use the highest concentration of that hazardous substance from any of the comparable samples in making the comparisons.

Treat sets of samples that are not comparable separately and make a separate comparison for each such set.

2.5.2 *Comparison to benchmarks.* Use the following media-specific benchmarks for making the comparisons for the indicated pathway (or threat):
• Maximum Contaminant Level Goals (MCLGs)—ground water migration pathway and drinking water threat in surface water migration pathway. Use only MCLG values greater than 0.
• Maximum Contaminant Levels (MCLs)—ground water migration pathway and drinking water threat in surface water m ..;ation pathway.
• Food and Drug Administration Action Level (FDAAL) for fish or shellfish—human food chain threat in surface water migration pathway.
• EPA Ambient Water Quality Criteria (AWQC) for protection of aquatic life—environmental threat in surface water migration pathway.
• EPA Ambient Aquatic Life Advisory Concentrations (AALAC)—environmental threat in surface water migration pathway.
• National Ambient Air Quality Standards (NAAQS)—air migration pathway.
• National Emission Standards for Hazardous Air Pollutants (NESHAPs)—air migration pathway. Use only those NESHAPs promulgated in ambient concentration units.
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• Screening concentration for cancer corresponding to that concentration that corresponds to the 10^{-6} individual cancer risk for inhalation exposures (air migration pathway) or for oral exposures (ground water migration pathway; drinking water and human food chain threats in surface water migration pathway; and soil exposure pathway).
• Screening concentration for noncancer toxicological responses corresponding to the RfD for inhalation exposures (air migration pathway) or for oral exposures (ground water migration pathway; drinking water and human food chain threats in surface water migration pathway; and soil exposure pathway).

Select the benchmark(s) applicable to the pathway (or threat) being evaluated as specified in sections 3 through 6. Compare the concentration of each hazardous substance from the sampling location to its benchmark concentration(s) for that pathway (or threat). Use only those samples and only those hazardous substances in the sample that meet the criteria for an observed release (or observed contamination) for the pathway, except tissue samples from aquatic human food chain organisms may be used as specified in sections 4.1.3.3 and 4.2.3.3. If the concentration of any applicable hazardous substance from any sample equals or exceeds its benchmark concentration, consider the sampling location to be subject to Level I concentrations for that pathway (or threat). If more than one benchmark applies to the hazardous substance, assign Level I if the concentration of the hazardous substance equals or exceeds the lowest applicable benchmark concentration.

If no hazardous substance individually equals or exceeds its benchmark concentration, but more than one hazardous substance either meets the criteria for an observed release (or observed contamination) for the sample (or comparable samples) or is eligible to be evaluated for a tissue sample (see sections 4.1.3.3 and 4.2.3.3), calculate the indices I and J specified below based on these hazardous substances.

For those hazardous substances that are carcinogens (that is, those having a carcinogen weight-of-evidence classification of A, B, or C), calculate an index I for the sample location as follows:

$$I = \sum_{i=1}^{n} \frac{C_i}{SC_i}$$

where:
C_i = Concentration of hazardous substance i in sample (or highest concentration of hazardous substance i from among comparable samples).
SC_i = Screening concentration for cancer corresponding to that concentration that corresponds to its 10^{-6} individual cancer risk for applicable exposure (inhalation or oral) for hazardous substance i.
n = Number of applicable hazardous substances in sample (or comparable samples) that are carcinogens and for which an SC_i is available.

For those hazardous substances for which an RfD is available, calculate an index J for the sample location as follows:

$$J = \sum_{j=1}^{m} \frac{C_j}{CR_j}$$

where:
C_j = Concentration of hazardous substance j in sample (or highest concentration of hazardous substance j from among comparable samples).
CR_j = Screening concentration for noncancer toxicological responses corresponding to RfD for applicable exposure (inhalation or oral) for hazardous substance j.
m = Number of applicable hazardous substances in sample (or comparable samples) for which a CR_j is available.

If either I or J equals or exceeds 1, consider the sampling location to be subject to Level I concentrations for that pathway (or threat). If both I and J are less than 1, consider the sampling location to be subject to Level II concentrations for that pathway (or threat). If, for the sampling location, there are sets of samples that are not comparable, calculate I and J separately for each such set, and use the highest calculated values of I and J to assign Level I and Level II.

See sections 7.3.1 and 7.3.2 for criteria for determining the level of contamination for radioactive substances.

3.0 *Ground Water Migration Pathway*

Evaluate the ground water migration pathway based on three factor categories: likelihood of release, waste characteristics, and targets. Figure 3–1 indicates the factors included within each factor category.

Determine the ground water migration pathway score (S_{gw}) in terms of the factor category values as follows:

$$S_{gw} = \frac{(LR)\ (WC)\ (T)}{SF}$$

where:
LR = Likelihood of release factor category value.
WC = Waste characteristics factor category value.
T = Targets factor category value.
SF = Scaling factor.

Table 3–1 outlines the specific calculation procedure.

Calculate a separate ground water migration pathway score for each aquifer, using the factor category values for that aquifer for likelihood of release, waste characteristics, and targets. In doing so, include both the targets using water from that aquifer and the targets using water from all overlying aquifers through which the hazardous substances would migrate to reach the aquifer being evaluated. Assign the highest ground water migration pathway score that results for any aquifer as the ground water migration pathway score for the site.

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